sixth day. For example, as the little pheasant was bolting with his worm, I seized it with a pair of forceps. This alarm or anger note was at once uttered, and the little fellow bridled up and seemed ready to show fight.

The birds when fresh run about with little short spurts or dashes, as do also chicks. They have a dislike to being confined. When they were surrounded with wire netting, although the space inside was ample for all their needs, they squeezed through the meshes, and did so very cleverly when four or five days old. At about this age or earlier they preen their down, and the incipient feathers of the wing, often tumbling over from imperfect co-ordination. They also peck persistently at their toes. They scratch the ground much less than chicks.

More difficulty was found in rearing the pheasants by hand than in the case of chicks. Several died apparently from constipation. None were reared beyond the fifteenth day. The coldness of the season was against them, and unfortunately, through an accident, the incubator drawer in which they slept was allowed to get cold, and this caused the death of the last two, one of which was quite healthy. I hope to repeat the observations, next year, on these and other young birds under more favourable conditions. Such as they are, however, they serve to confirm the conclusions based upon the study of newly-hatched chicks and ducklings, which I briefly set forth in *Natural Science* for March 1894, and which are considered at greater length in my "Introduction to Comparative Psychology," to be published this autumn in the Contemporary Science Series.

C. LLOYD MORGAN.

SCHOOLS OF METEOROLOGY.

IN your issue of September 13, p. 481, you correctly state that one reason for the small number of meteorologists is the want of a training school. This is a defect in our University curricula that I have frequently pointed out and sought to remedy. You will agree with me that meteorology is worthy of a generous and profound treatment. It should be recognised as a possible major course in all large Universities. Laboratories should be provided where all questions bearing on the atmosphere and its motions can be experimentally elucidated.

I append a sketch of the four years' course of study and work that I hope to carry out with my own students. The necessary laboratory conveniences have not yet been provided, but we are looking forward hopefully.

I shall be glad if your publication of this course contribute in any way to the proper study of meteorology by the young physicists of the British Empire.

CLEVELAND ABBE.

Washington, September 24.

COLUMBIAN UNIVERSITY.

Department of Meteorology.

The series of courses in the Department of Meteorology is designed to give a complete review of the present condition of that science, and is therefore necessarily extended through four years; but the series of lectures is so arranged that each of the four divisions is complete within itself; each course presents a view of a branch of the subject such as may be desired by a large number of students who need this information in connection with other branches of knowledge to which they are specially devoting themselves.

Students who intend to take the degree of Ph.D. in meteorology, and who therefore make this the major subject in connection with several other minor courses, must pursue the whole four years' course. Those who desire merely to enter the service of the United States Weather Bureau will probably find the first year's course sufficient to enable them to pass the necessary Civil Service examinations. Those who desire to do work in climatological study should also take the second year. The third year's course is designed for those who wish to perfect themselves in methods of making local weather forecasts. Finally, the fourth year's course will serve as an abundant introduction to the present state of our knowledge of the mechanics and physics of the atmosphere. In addition to the lectures, the instructor will give one hour a week to a quiz-class, in which, by question and answer, he will seek to remove any difficulties that remain.

(1) *Observational Meteorology.*—The methods of observation; the simpler instruments, their errors, corrections, and reductions; the use of self-registers; the forms of record and computation; personal diary of the weather.

Time.—About eighty lectures, or two hours a week, as also eighty other hours of personal investigation of instruments, especially self-registers.

Algebra and trigonometry are necessary preliminaries to this course. Elementary laboratory physics, as illustrated by Hall and Bergen's text-book, is desirable as a preliminary, but may be pursued as a concomitant study. The German language is earnestly recommended as a concomitant. The differential and integral calculus will be needed as preliminary to the Graduate Course in Meteorology.

(2) Climatology, both local and general; empirical meteorology, generalisations, averages, periodicities, irregularities. The relation of climate to geology, to vegetation, to animal life, and to anthropology.

Time.—About forty lectures and four hours weekly given to the investigation of special problems proposed in each lecture.

Students should be familiar with the use of logarithms; the method of least squares; the laws of chance; the details of physical geography, orography, geology, and ocean currents; the physiology of plants and animals; the distribution of species; physical astronomy, especially that of the sun, earth, and moon; terrestrial magnetism; the chemistry of the atmosphere; the biology of atmospheric dust. Physical laboratory work on radiation, conduction, and absorption of heat, and on condensation and evaporation of vapour, and on elementary electricity, is recommended, while German, the calculus and analytic mechanics should be continued as preliminary to the Graduate Course.

Graduate School of Meteorology.

The following scheme of studies in meteorology, subject to arrangement between the teacher and his pupils, is offered for the degree of Doctor of Philosophy:—

(1) Practical meteorology; the daily weather chart; the empirical laws of weather changes as depending on meteorological data, and the arrangement of continents, plateaus, mountains, oceans, &c.; weather types and typical weather charts; prediction of daily weather and seasonal climates; verification of predictions.

Time.—About forty lectures and at least five hours a week additional, in verifying old laws and studying new ones, in making and verifying predictions.

Concomitant Studies.—Methods of chart projection; experimental laboratory work in both steady and discontinuous motions of fluid and gases; mathematical and experimental electricity; the laws of refraction and interference of light; elementary hydrodynamics and thermodynamics; differential equations and definite integrals; the German language.

(2) Theoretical meteorology. Insolation. The absorption, conduction, and radiation of heat by the air and the earth. The thermodynamics of the atmosphere; the graphic methods of Hertz and Bezold. Convective equilibrium, as applied to the atmosphere of the sun by Lane, and to that of the earth by Sir William Thomson

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(Lord Kelvin) and his successors. Motion on a rotating globe; Ferrel's and other simple approximate relations between baric gradients and the wind and temperature; Ferrel's general circulation of the atmosphere and his cyclones and pericyclones and tornados. Galton's cyclone and anticyclone. Fourier's most general equations of gaseous motions. Oberbeck's general circulation. Helmholtz's horizontal rolls. The investigations of Diro Kitao, Guldberg and Mohn, Marchi, Boussinesq, A. Poincaré, Sprung, Siemens, Moeller, Ritter, and others into the motions of the atmosphere. Viscosity and discontinuous movements. The possible special solutions of the general equations of fluid motions that apply to the true atmospheric circulation, both on the earth and on the other planets. Atmospheric tides; theories of Laplace, Ferrel, Rayleigh, Margules, A. Poincaré. Theories of atmospheric electricity.

Time.—Eighty lectures and an additional four hours a week given to special reading and investigation, and to the preparation of the final thesis, as closing the four years' course.

Concomitant Studies. — Riemann's "Differential Gleichungen"; Auerbach's "Hydrodynamics"; Lamb's "Fluid Motions" (new edition); physical laboratory work in gaseous motions, optical and electrical phenomena.

THE ROYAL PHOTOGRAPHIC SOCIETY.

SIR H. TRUEMAN WOOD, the new President of the Royal Photographic Society, delivered an address at the opening meeting of the present session on Tuesday. After briefly tracing the development of the Society, he said:

"Turning aside from the consideration of the affairs of our own Society, to the general condition of photography, we find cause for nothing but congratulation. It is not so very long since photography occupied a very subordinate position in the world alike of science and of art. Scientific men looked on photography as a mere art, artists regarded it as a mere science. About twenty years ago, when I suggested that some improvement in a photographic process—I forget now which—ought to be brought before the Physical Section of the British Association, I was told that there was nothing scientific about photography, that it was a mere empirical pursuit, unworthy the attention of serious students of science.

"And to a large extent the reproach was well deserved. Though the list of the earliest workers in photography contains many illustrious names, yet it is true that a large proportion of the most important contributions to photographic knowledge were not made by scientific workers, or by men who worked in scientific methods. They were obtained by practical men, seeking for results; often, indeed, seeking for them successfully by methods which would not have commended themselves to men better equipped with scientific knowledge. Of course this was the consequence of the fact that photographic science was early associated with photographic practice; and the same remark holds good of other sciences, electricity for instance, in which theory and application to practical use advance with equal steps; but I think it applies more to photography than to any other.

"At the present time we have indeed reached a very different condition of things. All the most striking of the recent advances in the science are the result of elaborate scientific research. The most recent improvements in lenses were the fruit of long and laborious investigation into the optical properties and the chemical nature of certain sorts of glass. The increased speed of modern plates, and their improved power of rendering colour values more truly, have only been obtained by minute knowledge of the condition of the problem to be solved, and by careful application of the most recent results of chemical and physical research. If the old photographic crux, the reproduction of colour, has been solved, or, at all events, if a possible method has been indicated for its solution, it was not by haphazard experiment, but by careful adjustment of means to secure an anticipated result. Nowadays, we can only hope for improvement by utilising the advance of scientific knowledge.

"But if the present position of photography is due to progress in the kindred sciences, how amply has she repaid the debt! There is not a single branch of science in which photography is not largely used. There are many whose progress is now absolutely dependent on the power of the camera to observe more accurately, more independently, more minutely, more rapidly, more permanently, than the human eye. If, as appears to be the case, we have reached the limits of human vision, aided by the most delicate instruments that can be constructed, it is difficult to imagine what limits need be set to photographic vision, can we but construct instruments of accuracy sufficient to allow its full powers to be utilised.

"I imagine that the first application of photography to a scientific purpose must have been when Dr. Draper in New York photographed the moon. Whether the pictures he obtained were of any astronomical value, I do not know; certainly those taken a little later, in 1852, by Dr. Warren De la Rue, were, and they were the precursors of the long series of astronomical photographs culminating in Dr. Common's nebula of Orion, and in the great work of charting the heavens by photography which is now in progress.

"The advantages of the 'retina which never forgets,' and it might be added which never tires, which accumulates weak impressions and stores them up till they become one strong one, were long since recognised by De la Rue, and I suppose it will not be very long before, for astronomical purposes, eye observations are entirely superseded by photographic. The photographic camera is now an indispensable adjunct to every large telescope, if indeed it would not be equally correct to say that the telescope is an adjunct to the camera, since the astronomical telescope tends more and more to assimilate to the form adopted long since by Mr. Rutherford, in which the visual rays are treated of but slight importance, and the chief attention is given to the accurate utilisation of the more chemically active rays at the violet end of the spectrum.[1]

"In his recent address to the Photographic Convention at Dublin, Sir Howard Grubb, than whom nobody is better qualified to speak on the subject, dwelt on the services which photography has rendered to astronomy, and gave several striking illustrations of those services. Indeed, if one not qualified to speak on such matters with any authority might hazard an opinion, it would almost seem as if the power of recording observations had already outstripped the capacity for examining the observations, and drawing conclusions from them. When we are told that a photographic plate has recorded 10,000 stars in an area not containing a single visible star, one may be excused an expression of wonder as to how the human mind is ever to grapple with problems of such infinite complexity, to turn to useful account observations dealing with such enormous multitudes.

"But if the telescope has lately become one of the most important of photographic appliances, the spectroscope may be said to have held that position almost since its introduction. Mr. Norman Lockyer, in his well-known text-book, "Studies in Spectrum Analysis," attributes to

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[1] A good illustration of the telescope of the future would appear to be the 24-inch photographic refractor with an 18-inch visual telescope, now being constructed at the expense of Mr. McLean for the Cape Observatory.

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